Agency for Healthcare Research and Quality
Advancing Excellence in Health Care

NATIONAL GUIDELINE CLEARINGHOUSE

General

Guideline Title

Acute coronary syndrome and myocardial infarction.

Bibliographic Source(s)

Acute coronary syndrome and myocardial infarction. In: EBM Guidelines. Evidence-Based Medicine [database]. Helsinki, Finland: Wiley Interscience. John Wiley & Sons; 2011 Mar 1 [Various].

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Finnish Medical Society Duodecim. Acute coronary syndrome and myocardial infarction. In: EBM Guidelines. Evidence-Based Medicine [Internet]. Helsinki, Finland: Wiley Interscience. John Wiley & Sons; 2010 Apr 30 [Various]

Recommendations

Major Recommendations

The levels of evidence [A-D] supporting the recommendations are defined at the end of the "Major Recommendations" field.

Essentials

- The most common cause of an acute coronary event is a sudden rupture of an atherosclerotic plaque and the subsequent thrombus formation, which results in an abrupt reduction, or complete cessation, of blood flow within the coronary artery. The clinical manifestation of this phenomenon is known as acute coronary syndrome (ACS), and the term covers the following range of diagnoses:
  - ACS without ST elevation
    - Unstable angina (UA)
    - Non ST elevation myocardial infarction (NSTEMI)
  - ST elevation myocardial infarction (STEMI)
- See picture 1 in the original guideline document.

Symptoms and Clinical Diagnosis

- The diagnosis of ACS is based on the symptom history, clinical findings and electrocardiogram (ECG) changes. The diagnosis is confirmed if the concentration of cardiac biomarkers is increased. For non-ischaemic causes of chest pain, see table 1 below.
- Acute myocardial ischaemia causes chest pain with the following characteristics:
  - Starts abruptly, often severe, crushing, heavy or "band-like" in nature and not greatly affected by breathing or changing position

    - Prolonged, persists for over 20 minutes with constant intensity
    - Widespread in the retrosternal area, possibly radiating to the arms (usually to the left arm), back, neck or the jaw
    - In some patients may resemble the symptoms of acute abdomen (pain begins in the upper abdomen accompanied by nausea).
- Elderly patients and diabetics may, in particular, present with a feeling of general malaise, feeling of heaviness, sweating and nausea without chest pain.
- The pain may be the first occurrence of angina pain or it may be a known symptom of previously diagnosed stable angina which is worsening (over days – a few weeks) and is suggestive of UA.
- Particularly in inferior myocardial damage, severe vagotonia may induce bradycardia and hypotension which will manifest as dizziness or fainting.
- Other clinical manifestations of myocardial ischaemia include acute pulmonary oedema, loss of consciousness and sudden death.

Table 1. Non-ischaemic Causes of Chest Pain

Disease	Differentiating Signs and Symptoms
Aortic dissection	Sudden intense chest pain Blood pressure may be low and pulses asymmetrical New-onset aortic valve regurgitation Dissection may obstruct the origins of coronary arteries with signs of impending infarction Broad mediastinum on chest x-ray
Acute pulmonary embolism	Dyspnoea and tachypnoea as the principal symptoms Chest pain in about half of patients Tachycardia, right bundle branch block (RBBB), low blood pressure in extensive pulmonary embolism Chest x-ray is often normal Partial pressure of oxygen in arterial blood (PaO_2) decreased or normal, partial pressure of carbon dioxide in the blood ($PaCO_2$) decreased or normal D-dimer assay positive; negative result excludes pulmonary embolism with high probability
Spontaneous pneumothorax, tension pneumothorax	Dyspnoea, chest pain Quiet breath signs on auscultation Chest x-ray will confirm diagnosis
Oesophageal tear, perforated ulcer	Chest pain, upper abdominal pain
Pericarditis, myocarditis	Pain is usually retrosternal and is sharp or tearing in nature The pain is aggravated by inspiration, coughing and changing of position A friction rub may be heard ST–T changes with almost daily alternations
Pleuritis	Signs and symptoms of respiratory tract infection Stabbing chest pain, aggravated by inspiration and coughing
Costochondral pain	Pain on palpation Chest wall movements and breathing may aggravate the pain
Oesophageal inflammation or spasm, dyspepsia	Heartburn, chest pain, upper abdominal pain May be worse in recumbent position and on exertion (reflux) No ECG changes Relief from proton pump inhibitors (PPIs)
Early herpes zoster	No ECG changes Rash appears within a few days Localised paraesthesia before the appearance of the rash
Hyperventilation syndrome	Strong feeling of lack of air Fast and deep breathing Cold limbs with tingling and numbness

Disease	
	Dizziness, headache, dry mouth $PaCO_2$ decreased, PaO_2 in arterial blood increased or normal
Depression	Continuous feeling of heaviness in the chest, no correlation to exercise ECG normal

Diagnostic Investigations

Principles of ECG Diagnosis

- A 12 lead ECG is the most important diagnostic procedure. An ECG should be recorded immediately at the first point of care and again on arrival at hospital.
- Serial ECG recordings (every 15–30 minutes) are indicated if the pain continues, particularly when ECG changes are not noted in the initial recordings or changes are evident in the repeated recordings.
- The following additional leads should also be recorded: V4R (inferior and inferobasal ischaemia); V7 and V8 (lateral ischaemia).
- The position of the chest leads should be marked on the skin in the beginning to ensure the comparability of the subsequent recordings. This will prevent the changing of chest lead positions interfering with the ECG interpretation.
- A Q wave in an ECG will increase the likelihood of coronary heart disease (CHD).
- Differential diagnosis of ECG changes, see table 2 below.

Table 2. Conditions to Be Considered in the Differential Diagnosis of a Myocardial Infarction (MI) when Interpreting ECG Changes

ECG Change	To Be Considered in the Differential Diagnosis
ST elevation	Early repolarisation Perimyocarditis Hypertrophic cardiomyopathy Brugada syndrome Pulmonary embolism Hyperkalaemia Left ventricular hypertrophy
ST depression	Sympathicotonia Hyperventilation Microvascular angina Left ventricular hypertrophy Digoxin Post tachyarrhythmia Mitral prolapsed
T wave change	Normal variant Hyperventilation Increased intracranial pressure An electrolyte disturbance Acute cor pulmonale (pulmonary embolism) Takotsubo syndrome
Q wave	Left ventricular hypertrophy (Lead V1) Hypertrophic cardiomyopathy Right ventricular pressure and volume overload Pneumothorax Duchenne muscular dystrophy Abnormal position of the heart (Leads II, III and aVF) Myocarditis Left anterior fascicular block (right sided chest leads)

Source: Nikus et al. Akuuttien sepelvaltimo-oireyhtymien diagnoosi, luokittelu ja epidemiologia (Diagnosis, classification and epidemiology of acute coronary syndromes (In Finnish). Publication: Heikkilä et al. (ed.) Kardiologia, Kustannus Oy Duodecim, 2008, p. 447.

ECG Diagnosis: UA and Non ST Elevation Myocardial Infarction (NSTEMI)

- New ST depression >0.5 mm in two contiguous leads, even transient, is suggestive of myocardial ischaemia in a patient with chest pain.
- Deep and widespread ST depression is suggestive of extensive ischaemia and a worse prognosis.
- T wave inversion (>1 mm) in two contiguous leads with R/S ratio >1.
- Deeply inverted T waves (>2 mm)
- A normal ECG recording does not exclude acute myocardial ischaemia.
- Reciprocal ST depression in leads V1–V4 may be a manifestation of posterior wall ischaemia. However, in addition to the ST depression, ST elevation in lead V8 (only posterior wall involvement) and possibly also in the inferior leads II, III and aVF (posterior-inferior wall involvement).

ECG Diagnosis: ST Elevation Myocardial Infarction (STEMI; Also Criteria for Coronary Reperfusion)

- New ST elevation >2 mm in men or >1.5 mm in women in leads V2–V3, or ST elevation >1 mm in at least two other contiguous leads (contiguous leads refer to lead groups, i.e. lateral leads I, aVL; inferior leads II, III, and aVF; anterior leads V1–V6).
- New left bundle branch block (LBBB) with chest pain.

Cardiac Biomarkers

- Myocardial ischaemia causes tissue damage and myocardial cell death with the consequent release of cardiac biomarkers into the circulation (cardiac troponin TnT and TnI; creatine kinase isoenzyme myocardial band [MB] mass, creatine kinase [CK]-MBm).
- The troponin concentration is the primary investigation; it is considered to be a more sensitive and specific indicator of an MI than CK-MBm.
- The troponin concentration is measured on arrival and again when 6–8 hours have elapsed from the onset of chest pain. The test may be repeated once or twice with an interval of 6–8 hours.
- Even a slightly increased troponin concentration (>99th percentile of a normal reference population) is a positive finding.
- The plasma concentration of troponin T increases on average about 6 hours after the onset of chest pain (interpatient variation 3–8 hours), and the concentration may remain elevated for two or even three weeks.
- The CK-MBm measurement may be used in special cases (a suspicion of recurrent ischaemia soon after the initial MI, renal failure).
- The CK-MBm concentration increases in the plasma 3–8 hours after the coronary occlusion (peak in 20–24 hours) and returns to normal within 50–70 hours.
- If the troponin concentration is normal 12 hours after the onset of chest pain, ACS is unlikely.
- Increased troponin concentrations may be present in the absence of an MI if myocardial damage has occurred due to other causes, such as myocarditis, heart failure, cardiomyopathy and following an episode of tachyarrhythmia. The concentration will also increase in pulmonary embolism, sepsis and renal failure.

Other Investigations

- A chest x-ray should be taken in the hospital to aid the haemodynamic assessment.
- Echocardiography is indicated if there are signs of heart failure, haemodynamic instability or frequent arrhythmias.

Treatment of UA and NSTEMI

- The risk of death and further cardiac events in patients with UA or NSTEMI is greatest during the first few days after the acute event, and the risk will remain increased during the first month. In order to identify the optimal treatment approach, the risk of short-term adverse outcomes must therefore be assessed (history, physical examination and ECG) without delay in all patients who are suspected to have cardiac chest pain. The more the high-risk criteria are fulfilled (see table 3 below) the greater the likelihood of a cardiac event.
- The treatment should be carried out in a coronary care unit or another ward with facilities to continuously monitor the patient for the occurrence of haemodynamic instability or ischaemia.

Table 3. Short-term Risk Stratification in UA and NSTEMI

Risk Category	Risk Assessment Criteria
High risk	More frequent episodes of chest pain during the preceding 48 hours

Risk Category	Risk Assessment Criteria
	Prolonged chest pain Increased troponin concentration ST depression or transient ST elevation on ECG Haemodynamic instability Diabetes Arrhythmia (ventricular tachycardia or ventricular fibrillation) New or worsened mitral regurgitation murmur or ventricular gallop Ischaemia-induced heart failure
Low risk	No further chest pain after admission Troponin concentration normal on two measurements, the second one measured 9–12 hours after the onset of pain No ischaemic changes on ECG

Source: Vikman et al. Epävakaan angina pectoriksen ja ei-ST-nousuinfarktin hoito (Treatment of unstable angina pectoris and non-ST elevation myocardial infarction. In Finnish). Publication: Heikkilä et al. (ed.) Kardiologia, Kustannus Oy Duodecim, 2008, p. 459.

Initial Management

- Supplemental oxygen 4–6 l/min for the first few hours. Thereafter the need for oxygen therapy is decided according to the patient's oxygen saturation level.
- Short-acting nitrate spray to relieve chest pain, may be repeated twice with an interval of five minutes if necessary.
- Aspirin 250 mg to chew and swallow, unless the patient is already taking aspirin. It is recommended that a non-enteric coated preparation be used. The initial dose should be followed by long-term treatment of aspirin 100 mg/day, unless contraindicated (Natarajan, 2002; "Collaborative overview," 1994) [A].
- For persistent chest pain, an initial dose of morphine 4–8 mg followed by repeated intravenous bolus doses of 2–4 mg.
- If reassurance is not sufficient to calm the patient, intravenous diazepam 2.5–5 mg may be given.

Antithrombotic Therapy

- Clopidogrel co-administered with aspirin: the initial loading dose is 600 mg, followed by 75 mg/day (Squizzato et al., 2011; Yusuf et al., 2001) [A].
- Low molecular weight heparin; enoxaparin 1 mg/kg twice daily subcutaneous (s.c.) or dalteparin 120 IU/kg twice daily, the dose should be reduced in patients >75 years (–25%) and in renal failure.
- A glycoprotein IIb/IIIa receptor blocker for high risk patients in specialist health care.
- Thrombolysis is of no benefit.
- If the patient is being treated with warfarin, heparin should not be started until international normalised ratio (INR) has reduced to near the lower limit of the recommended target range. If indicated, particularly if INR is too high, the action of warfarin can be reversed by administering Vitamin K1 (phytomenadione) 1–3 mg intravenously, even though there is only limited evidence of its benefit. Other antithrombotic therapy should be administered according to appropriate protocols.
- The risk of bleeding must always be assessed. The following increase the risk: age >75 years, renal failure, female gender, systolic blood pressure (BP) >160 mm Hg and a previous history of a bleeding tendency.

Anti-Ischaemic and Other Treatment

- A nitrate infusion if the chest pain persists provided that the patient is not hypotensive (systolic BP should be >100 mm Hg) or hypovolaemic and exhibits no signs of right ventricular infarction.
    - The initial dose is 20 µg/min = 12 ml/hour when the concentration is 100 µg/ml. If necessary, the dose may be increased by 12 ml/hour every few minutes up to 120 ml/hour whilst closely monitoring blood pressure.
- A beta blocker (Natarajan, 2002) [C] (metoprolol) intravenously as 2.5–5 mg bolus doses. Caution must be exercised if bradycardia, conduction defects or hypotension are present. The aim is to achieve a heart rate of 50–60/min and systolic BP <150 mm Hg. In heart failure, the target heart rate is higher (i.e., 70–80/min).
- Early introduction of a statin is recommended (i.e. during the first day of treatment).
- Non-steroidal anti-inflammatory drugs (NSAIDs) should be stopped and should not be used for pain relief.

Invasive Treatment, Revascularisation (Percutaneous Transluminal Coronary Angioplasty [PTCA] and Coronary Artery Bypass Surgery [CABG])

- UA and NSTEMI are usually caused by an abrupt rupture of an atherosclerotic plaque and the subsequent blood clot formation, which

leads to a marked occlusion within the coronary artery. High-risk patients (see table 3 above) benefit from early revascularisation, which reduces the incidence of further cardiac events, as compared with pharmacotherapy alone (Hoenig, Aroney, & Scott, 2010; Qayyum et al., 2008; Hirsch et al., 2007) [C].
    - Coronary angiography and revascularisation should be carried out within 24–48 hours of the onset of chest pain.
    - In most cases only the occluded artery is treated, and other possible occlusions are treated at a later date.
    - Before proceeding with an invasive procedure, the procedural risk must be assessed, particularly for elderly patients and those with several comorbidities.
- Patients admitted with chest pain, but who do not fulfil the high-risk criteria and who remain pain free after admission, should undergo an exercise test within 2–3 days.
    - If the exercise test findings are consistent with myocardial ischaemia, coronary angiography is performed within the next few weeks, depending on the extent of the ischaemia.
    - If the patient's exercise tolerance is totally normal, and no further episodes of chest pain or ECG changes occur, the patient's 12-month cardiac event risk is small. Risk factor management should continue. Additional investigations may be needed if chest pain is thought to be caused by a non-cardiac aetiology.

Treatment of STEMI

- STEMI is often the first presentation of coronary heart disease (CHD) without preceding angina pain. The patient may therefore not necessarily be able to interpret the symptoms as originating from the heart, which results in an unnecessary delay before the first medical contact is made.
- It is of the utmost importance that primary care providers are able to recognise the symptoms since STEMI is associated with a high risk of life threatening arrhythmias, conduction defects and sudden death. In order to facilitate the easy identification and management of STEMI, integrated care pathways incorporating local guidelines should be implemented in all health care facilities providing on-call services.
- A diagnosis should be made as quickly as possible, and an ECG must be recorded as soon as the first medical contact is made. Serial ECGs should be recorded if no changes are noted but the symptoms are suggestive of an MI.
- If STEMI is confirmed, the patient's heart rate and blood pressure must be monitored and a venous access obtained.

Initial Management

- Supplemental oxygen 4–6 l/min for the first few hours. Thereafter the need for oxygen therapy is decided according to the patient's oxygen saturation level.
- Short-acting nitrate spray to relieve chest pain, may be repeated twice with an interval of five minutes if necessary.
- Aspirin 250 mg to chew and swallow, unless the patient is already taking aspirin. It is recommended that a non-enteric coated preparation be used. The initial dose should be followed by long-term treatment of aspirin 100 mg/day, unless contraindicated (Natarajan, 2002; "Collaborative overview," 1994) [A].
- For persistent chest pain, an initial dose of morphine 4–8 mg followed by repeated intravenous bolus doses of 2–4 mg.
- If reassurance is not sufficient to calm the patient, intravenous diazepam 2.5–5 mg may be given.
- If arrhythmias occur, a beta blocker may be commenced during the initial management period, otherwise a beta blocker is introduced in hospital, during the first 24 hours, after the haemodynamic state has been stabilised and provided that there are no contraindications.

Reperfusion: Thrombolytic Therapy or Percutaneous Coronary Intervention (PCI)?

- The initial treatment procedures must not delay the evaluation for reperfusion therapy. The evaluation should address the time of symptom onset, cardiac risk factors, the patient's suitability for thrombolytic therapy (see contraindications in table 4 below), the local availability of primary PCI and the time required for transport to a PCI-capable hospital.
- Reperfusion therapy consists of either thrombolytic therapy or emergency primary PCI (direct balloon angioplasty).
- According to the current guidelines, urgent primary PCI is the first-line choice if it can be carried out within 90 minutes of the first medical contact and if the time difference between the possible onset of thrombolysis and PCI is not greater than 60 minutes.
- The best results are achieved with thrombolytic therapy if it is administered within 1 to 2 hours of symptom onset. The benefit of the treatment is markedly reduced when more than 6 hours have elapsed from the symptom onset and hardly any benefit is to be expected when more than 12 hours have elapsed from the symptom onset.
- Thrombolytic therapy is favoured if the symptom duration is short (less than 3 hours), the patient's condition is haemodynamically stable, primary PCI is not available or the transport time to a PCI-capable hospital is too long, provided that the patient is suitable for thrombolysis (see table 4 below).
    - Agents used in thrombolytic therapy and their doses are presented in table 5 below.
        - Reteplase is administered in two doses with an interval of 30 minutes and tenecteplase is given as a bolus injection. These

agents are easy to administer and are therefore well suited for pre-hospital administration.
    - According to current guidelines, thrombolytic therapy should be started within 30 minutes of the arrival of emergency medical services on scene.
- Primary PCI is favoured in the following situations: a high-risk MI (signs of heart failure, haemodynamic instability), the patient is ineligible for thrombolytic therapy, a long symptom duration and uncertainty of the STEMI diagnosis.
- Pretreatment before thrombolytic therapy
    - Patients under 75 years should be given oral clopidogrel 300 mg, followed by 75 mg daily
        - Patients over 75 years are to start directly with the maintenance dose
    - Patients under 75 years, provided that significant renal impairment (creatinine <175 µmol/l in women and <220 in men) is not present, should be given enoxaparin 30 mg intravenously followed by a subcutaneous dose of 1.0 mg/kg 15 minutes later. The total dose must not exceed 100 mg.
        - Patients over 75 years should not be given an intravenous bolus dose but 0.75 mg/kg subcutaneously, up to a single dose of 75 mg.
        - If renal impairment is present, the doses should be reduced.
- Consult first with the cardiologist on call at the PCI centre regarding the feasibility of primary PCI and the antithrombotic medication.
- Pretreatment before PCI: oral prasugrel 60 mg is recommended. If the patient has received prasugrel, thrombolytic therapy must not be given.
- Patients with STEMI who decline reperfusion therapy, or in whom it is not possible due to comorbidities, are treated with aspirin, clopidogrel, heparin and other medication as considered suitable at the given situation.

Table 4. Contraindications to Thrombolytic Therapy in STEMI

Absolute Contraindications	Relative Contraindications
Ischaemic stroke in preceding 6 months	Transient ischemic attack (TIA) in preceding 6 months
Haemorrhagic stroke or stroke of unknown origin at any time	Anticoagulant therapy
Central nervous system neoplasms or blood vessel anomalies	Pregnancy or within 1 week post partum
Major tissue damage or surgery within preceding 3 weeks	Systolic BP >180 mmHg or diastolic BP > 110 mmHg, refractory to treatment
Major head or facial trauma within preceding 3 months	Significant liver disease
Gastrointestinal bleeding within one month	Infective endocarditis
Known bleeding disorder	Active peptic ulcer
Confirmed or suspected aortic dissection	
Recent intervention (liver biopsy, lumbar puncture)	

Table 5. Agents Used in Thrombolytic Therapy

Drug	Initial Dose	
Tenecteplase	Single intravenous (i.v.) bolus dose according to weight	
	Weight <60 kg	30 mg
	60-69 kg	35 mg
	70-79 kg	40 mg
	80-89 kg	45 mg
	≥90 kg	50 mg
Reteplase	10 units × 2 intravenous bolus doses given 30 minutes apart	

Drug	Initial Dose
Alteplase	15 mg intravenous bolus, 0.75 mg/kg over 30 minutes, 0.5 mg/kg over 60 minutes, total dose not to exceed 100 mg

Complications of Thrombolytic Therapy

- Intracranial bleed is a rare (1–2%) but serious complication of thrombolytic therapy. The signs of intracranial haemorrhage include a reduced level of consciousness and neurological deficits.
    - If haemorrhage is suspected or the patient exhibits cerebral symptoms, a computed tomography (CT) scan of the head must be carried out.
- Intestinal and other non-cerebral bleeds are more frequent (5–10%) than intracranial haemorrhage.
- Bleeding complications associated with thrombolytic therapy usually appear within 24 hours.
- Age >75 years, female gender, systolic BP >160 mm Hg, lighter body weight and concurrent anticoagulant therapy are significant predictors of haemorrhage.

Assessment of Revascularisation

- The most useful sign of successful thrombolysis is ST segment resolution >50% in the lead with the highest elevation within 90 minutes of the start of thrombolytic therapy.
- Disappearance of chest pain and reperfusion arrhythmias are suggestive findings but when appearing alone are not sufficient to confirm revascularisation.
- Thrombolysis fails in about one third of patients.
    - If thrombolysis fails, the patient must be sent for PCI without delay.
- Reocclusion develops during hospitalisation in about 20% of patients after initial successful thrombolysis.
- As a rule, coronary angiography within a few days is recommended even after successful thrombolysis.

Arrhythmias in the Acute Phase

Causes

- The mechanisms of arrhythmias include myocardial ischaemia and damage, reperfusion changes, autonomic imbalances as well as electrolyte and acid-base disturbances.

Ventricular Fibrillation (VF)

- Primary VF occurring within 24–48 hours of the onset of STEMI does not increase long-term mortality.
- VF is treated with immediate defibrillation. Recurrent VF is treated with defibrillation and amiodarone.
- The risk of recurrence can be reduced by optimising the drug therapy for myocardial ischaemia and heart failure (adequate beta blockade, angiotensin-converting enzyme [ACE] inhibitors, nitrates). Similarly, electrolyte disturbances must be corrected as well as factors associated with fluid balance and oxygenation.

Ventricular Tachycardia (VT)

- Repeated and prolonged episodes of VT are suggestive of a worsening heart disease and are an indication for more detailed ischaemia studies (coronary angiography) and an assessment of the extent of heart failure (echocardiography).
- Monomorphic VT that is either sustained or causes haemodynamic instability is treated with immediate direct current (DC) cardioversion. If the arrhythmia recurs it should be treated with intravenous amiodarone, and sotalol or lidocaine may also be used.
- If monomorphic non-sustained VT recurs frequently, it is treated with intravenous amiodarone or sotalol, or other beta blocker.
- The treatment of polymorphic VT consists of sotalol, other beta blocker or amiodarone, provided that the QRS complex is not widened in an ECG taken during sinus rhythm.
- If the QRS complex is widened, a magnesium infusion may be given, and the electrolytes should be checked. Temporary pacing with overdrive may be indicated as well as urgent coronary angiography.

Other Ventricular Arrhythmias

- Ventricular ectopic beats are common in patients with MI during the first few days of treatment and no specific treatment is required.
- Idioventricular rhythm is a consequence of reperfusion and requires no specific treatment. Similarly, salvos of non-sustained VT (<30 seconds) require no specific treatment. None of the above mentioned arrhythmias serve as reliable predictors of VF.

Atrial Fibrillation (AF)

- AF is common in the acute phase of an MI (10–20%) and does not require treatment if it is haemodynamically well tolerated. AF often terminates spontaneously.
- It is more prevalent in older patients with MI and in patients with left ventricular dysfunction or failure.
- AF increases the risk of stroke and in-hospital mortality.
- Anticoagulant therapy is indicated unless the patient is already receiving an anticoagulant (heparin).
- An intravenous beta blocker may be used to provide ventricular rate control in AF. Digoxin may also be used, particularly in left ventricular dysfunction or heart failure.
- If a beta blocker and digoxin do not provide adequate rate control, intravenous amiodarone may be given.

Sinus Bradycardia and Atrioventricular (AV) Conduction Disturbances

- Sinus bradycardia is common in the first few hours of an MI, particularly in inferior infarction. Opiates may also predispose to sinus bradycardia. If sinus bradycardia causes haemodynamic compromise it should be treated with atropine 0.5 mg intravenously, followed by supplemental doses of 0.2–0.3 mg up to 2.0 mg.
- First-degree AV block is often associated with inferior wall damage and is usually transient requiring no treatment.
- More serious conduction disturbances, such as second- and third-degree AV block as well as LBBB, RBBB and left fascicular block indicate extensive myocardial damage and the placing of a temporary pacing electrode may be warranted. In some cases, permanent pacing is required. In second-degree AV block, atropine may improve the conduction. Isoprenaline may provide temporary help. Transient AV block is most commonly associated with an inferior MI.

Antiarrhythmic Medication

- Antiarrhythmic and antibradycardia medications are presented in table 6 below.

Table 6. Intravenous Doses of Antiarrhythmic and Antibradycardia Medications

Drug	Intravenous Dose
Amiodarone	150 mg over 10 minutes. Supplemental bolus doses of 150 mg may be given over 10–30 minutes for recurrent arrhythmias, but limited to 6–8 supplemental boluses in any 24 hour period. A maintenance infusion of 1 mg/min for 6 hours followed by 0.5 mg/min may be necessary after the initial dose.
Metoprolol	2.5–5 mg over 2 minutes, up to 3 doses
Digoxin	0.25 mg every other hour, up to 1.0 mg
Lidocaine	0.5–0.75 mg/kg
Verapamil	0.075–0.15 mg/kg over 2 minutes
Atropine	Rapid bolus dose of at least 0.5 mg, repeated up to a total dose of 1.5–2.0 mg (0.04 mg/kg)
Isoprenaline	0.05–0.1 μg/kg/min, up to 2 μg/kg/min. The dose should be adjusted to heart rate and rhythm.

Adapted from the source: Eur Heart J 2008;29:2909-2945.

Right Ventricular Infarction

- Right ventricular infarction is caused by the occlusion of the proximal right coronary artery.

Symptoms and Diagnosis

- Clinical symptoms are hypotension and high jugular venous pressure. However, a chest x-ray will fail to demonstrate venous congestion or pulmonary oedema.
- ST elevation ≥1 mm in lead V4R is strongly suggestive of right ventricular infarction. Q-waves and/or ST elevation in V1–V3 are also suggestive of right ventricular damage.
- AF may lead to haemodynamic collapse when the synchrony between the atria and ventricles is lost. AF must be promptly treated aiming to restore sinus rhythm. AV conduction disturbances are treated with atropine or dual chamber pacing.

Treatment

- Early reperfusion, see the treatment of STEMI.
- Hypotension is treated with adequate intravenous fluid loading, initially 500–1,000 ml, in order to maintain adequate preload. Dobutamine may be indicated.
- It is desirable to avoid drugs that lower blood pressure, such as ACE inhibitors, angiotensin receptor blockers, nitrates, diuretics and opioids.

Inpatient Treatment

Monitoring and Care

- Continuous cardiac monitoring is indicated during the first few treatment days, preferably in a coronary care unit.
- In an uncomplicated MI, the patient is allowed to sit up straightaway, eat unassisted and use the commode at the bedside.
- In a complicated MI (heart failure, arrhythmias) bed rest should continue longer (2–4 days), mobilisation when considered appropriate.
- An ACE inhibitor (Perez, Musini, & Wright, 2009) [A] should be introduced during the first treatment day. If an ACE inhibitor is not suitable, an angiotensin receptor blocker should be prescribed.
- A beta blocker is started during the hospitalisation period as soon as the patient is haemodynamically stable.
- Nicotine replacement therapy is introduced for smokers.
- Patient education and motivation for treatment is important. The patient should be given information about the disease, the associated drug therapy as well as the modification of risk factors.

Level of Care

- If the patient's prognosis is otherwise poor, treatment of an MI may justifiably be carried out in a care facility other than a large hospital. This involves patients in institutional care or those so severely disabled that invasive treatment is not considered appropriate.

Follow-up Management

- The follow-up management of ACS consists of antithrombotic and anti-ischaemic drug therapy as well as modification of risk factors with lifestyle changes and pharmacotherapy.
- Aspirin long-term 100 mg daily. Clopidogrel 75 mg daily for patients with aspirin allergy.
- Clopidogrel is used in the treatment of ACS; both during the acute hospital phase and in the continued treatment (9–12 months) after the acute event, 75 mg daily. After the insertion of a coronary stent, clopidogrel significantly decreases the incidence of stent thrombosis and should be included in the medication. The treatment is continued for 3 to 12 months depending on the case.
- If anticoagulation therapy is necessary due to some other indication, after insertion of a metal stent the patient is given triple therapy (aspirin [ASA] + clopidogrel + warfarin) for 1–6 months, then clopidogrel + warfarin for 6–12 months, and thereafter only warfarin. Treatment durations are affected by the patient's bleeding risk. The insertion of drug-eluting stents is avoided in patients on permanent anticoagulation therapy.
- Anticoagulant therapy is indicated for patients with a left ventricular thrombus, for 3–6 months. Anticoagulant therapy must continue if AF keeps recurring or becomes permanent.
- An ACE inhibitor should be prescribed for all patients with MI. The recommended maintenance doses should be used, or the highest tolerated dose. If an ACE inhibitor is not suitable, an angiotensin receptor blocker should be prescribed.
- A statin should be prescribed for all patients with MI. Fibrates and omega-3 supplements should be considered when statins are not suitable. For the aims of lipid treatment, see the Finnish Medical Society Duodecim guideline "Coronary Heart Disease."
- A beta blocker should be prescribed for all patients with MI unless contraindicated. The aim is a heart rate of 50–60/minute at rest.
- Calcium-channel blockers are mainly appropriate for the treatment of hypertension and/or chest pain if beta blockers are not suitable. It should, however, be borne in mind that there is no evidence of the benefit of calcium-channel blockers in terms of improved prognosis in CHD. See the Finnish Medical Society Duodecim guideline "Coronary Heart Disease."
- A prescription for short-acting glyceryl trinitrate (GTN) should always be given to the patient on discharge after an MI.
- Long-acting nitrates are reserved for patients with continuing chest pain.
- Influenza immunisation is indicated for all patients who have had an MI.
- After the hospitalisation phase, the long-term management of patients who have sustained an MI will almost without exception be the responsibility of the general practitioner. Primary care health providers are therefore in a key position to motivate the patient to adopt permanent lifestyle changes and to ensure that drug therapies to manage risk factors and improve prognosis are adhered to and that regular primary care follow-up visits are arranged.

Related Evidence

Refer to the original guideline document for related evidence, including Cochrane reviews and other evidence summaries.

Definitions:

Classification of the Quality of Evidence

Code	Quality of Evidence	Definition
A	High	Further research is very unlikely to change confidence in the estimate of effect. • Several high-quality studies with consistent results • In special cases: one large, high-quality multi-centre trial
B	Moderate	Further research is likely to have an important impact on confidence in the estimate of effect and may change the estimate. • One high-quality study • Several studies with some limitations
C	Low	Further research is very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate. • One or more studies with severe limitations
D	Very Low	Any estimate of effect is very uncertain. • Expert opinion • No direct research evidence • One or more studies with very severe limitations

GRADE (Grading of Recommendations Assessment, Development and Evaluation) Working Group (modified by the EBM Guidelines Editorial Team).

Clinical Algorithm(s)

An algorithm for diagnostic classification of acute coronary syndromes based on electrocardiogram (ECG) findings and troponin concentrations is included in the original guideline document (Picture 1).

Scope

Disease/Condition(s)

Acute coronary syndromes, including:

- Unstable angina (UA)
- Non ST elevation myocardial infarction (NSTEMI)
- ST elevation myocardial infarction (STEMI)

Guideline Category

Diagnosis

Evaluation

Risk Assessment

Treatment

Clinical Specialty

Cardiology

Critical Care

Emergency Medicine

Family Practice

Internal Medicine

Intended Users

Emergency Medical Technicians/Paramedics

Health Care Providers

Physicians

Guideline Objective(s)

Evidence-Based Medicine Guidelines collect, summarize, and update the core clinical knowledge essential in general practice. The guidelines also describe the scientific evidence underlying the given recommendations.

Target Population

People with ischemic chest pain suggesting unstable angina or myocardial infarction

Interventions and Practices Considered

Diagnosis/Evaluation/Risk Assessment

1. Symptom history
2. 12-lead electrocardiogram (ECG)
3. Serial ECG recordings
4. Risk factor assessment
5. Measurement of cardiac biomarkers (troponins)
6. Other investigations including chest x-ray and echocardiography, as indicated

Treatment/Management

1. Supplemental oxygen
2. Nitrate therapy
3. Aspirin
4. Morphine for persistent pain
5. Diazepam, for anxiety
6. Clopidogrel in addition to aspirin
7. Low-molecular-weight (LMW) heparin (such as enoxaparin and dalteparin)

8. Glycoprotein IIb/IIIa receptor blocker in selected patients
9. Beta-blocker (metoprolol)
10. Statin therapy
11. Calcium-channel blockers
12. Revascularization (percutaneous transluminal coronary angioplasty [PTCA] and coronary artery bypass graft [CABG])
13. Coronary angiography
14. Exercise testing
15. Thrombolytic therapy, including pretreatment
16. Percutaneous coronary intervention (balloon angioplasty), including pretreatment
17. Defibrillation
18. Amiodarone, sotalol, and other antiarrhythmic medications
19. Continuous cardiac monitoring
20. Bed rest, in specified cases
21. Nicotine replacement therapy, for smokers
22. Patient education
23. Short-acting glycerol trinitrate (GTN) on discharge

Major Outcomes Considered

- Mortality
- Incidence of myocardial infarction
- Incidence of ischaemic events/recurrent angina
- Sensitivity and specificity of diagnostic tests

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

The evidence reviewed was collected from the Cochrane database of systematic reviews and the Database of Abstracts of Reviews of Effectiveness (DARE). In addition, the Cochrane Library and medical journals were searched specifically for original publications.

Number of Source Documents

Not stated

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

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GRADE (Grading of Recommendations Assessment, Development and Evaluation) Working Group (modified by the EBM Guidelines Editorial Team).

Methods Used to Analyze the Evidence

Systematic Review

Description of the Methods Used to Analyze the Evidence

Not stated

Methods Used to Formulate the Recommendations

Not stated

Rating Scheme for the Strength of the Recommendations

Not applicable

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Peer Review

Description of Method of Guideline Validation

Not stated

Evidence Supporting the Recommendations

References Supporting the Recommendations

Collaborative overview of randomised trials of antiplatelet therapy--I: Prevention of death, myocardial infarction, and stroke by prolonged antiplatelet therapy in various categories of patients. Antiplatelet Trialists' Collaboration. BMJ. 1994 Jan 8;308(6921):81-106. PubMed

Hirsch A, Windhausen F, Tijssen JG, Verheugt FW, Cornel JH, de Winter RJ, Invasive versus Conservative Treatment in Unstable coronary Syndromes (ICTUS). Long-term outcome after an early invasive versus selective invasive treatment strategy in patients with non-ST-elevation acute coronary syndrome and elevated cardiac troponin T (the ICTUS trial): a follow-up study. Lancet. 2007 Mar 10;369(9564):827-35. PubMed

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Squizzato A, Keller T, Romualdi E, Middeldorp S. Clopidogrel plus aspirin versus aspirin alone for preventing cardiovascular disease. Cochrane Database Syst Rev. 2011;(1):CD005158. PubMed

Yusuf S, Zhao F, Mehta SR, Chrolavicius S, Tognoni G, Fox KK. Effects of clopidogrel in addition to aspirin in patients with acute coronary syndromes without ST-segment elevation. N Engl J Med. 2001 Aug 16;345(7):494-502. PubMed

Type of Evidence Supporting the Recommendations

Concise summaries of scientific evidence attached to the individual guidelines are the unique feature of the Evidence-Based Medicine Guidelines. The evidence summaries allow the clinician to judge how well-founded the treatment recommendations are. The type of supporting evidence is identified and graded for select recommendations (see the "Major Recommendations" field).

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Appropriate diagnosis and treatment of acute coronary syndrome and myocardial infarction

Potential Harms

- The risk of bleeding must always be assessed with antithrombotic therapy. The following increase the risk: age >75 years, renal failure, female gender, systolic blood pressure (BP) >160 mm Hg and a previous history of a bleeding tendency.
- Caution must be exercised with beta blockers if bradycardia, conduction defects or hypotension are present.

Complications of Thrombolytic Therapy

- Intracranial bleed is a rare (1–2%) but serious complication of thrombolytic therapy. The signs of intracranial haemorrhage include a reduced level of consciousness and neurological deficits.
    - If haemorrhage is suspected or the patient exhibits cerebral symptoms, a computed tomography (CT) scan of the head must be carried out.
- Intestinal and other non-cerebral bleeds are more frequent (5–10%) than intracranial haemorrhage.
- Bleeding complications associated with thrombolytic therapy usually appear within 24 hours.
- Age >75 years, female gender, systolic BP >160 mm Hg, lighter body weight and concurrent anticoagulant therapy are significant predictors of haemorrhage.

Contraindications

Contraindications

Refer to the "Major Recommendations" field for contraindications to thrombolytic therapy in ST-segment elevation myocardial infarction (STEMI).

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Implementation Tools

Clinical Algorithm

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Timeliness

Identifying Information and Availability

Bibliographic Source(s)

Acute coronary syndrome and myocardial infarction. In: EBM Guidelines. Evidence-Based Medicine [database]. Helsinki, Finland: Wiley Interscience. John Wiley & Sons; 2011 Mar 1 [Various].

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2001 Apr 30 (revised 2011 Mar 1)

Guideline Developer(s)

Finnish Medical Society Duodecim - Professional Association

Source(s) of Funding

Finnish Medical Society Duodecim

Guideline Committee

Editorial Team of EBM Guidelines

Composition of Group That Authored the Guideline

Primary Authors: Helena Kervinen

Financial Disclosures/Conflicts of Interest

Not stated

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Finnish Medical Society Duodecim. Acute coronary syndrome and myocardial infarction. In: EBM Guidelines. Evidence-Based Medicine [Internet]. Helsinki, Finland: Wiley Interscience. John Wiley & Sons; 2010 Apr 30 [Various]

Guideline Availability

This guideline is included in "EBM Guidelines. Evidence-Based Medicine" available from Duodecim Medical Publications, Ltd, PO Box 713, 00101 Helsinki, Finland; e-mail: info@ebm-guidelines.com; Web site: www.ebm-guidelines.com .

Availability of Companion Documents

None available

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on May 11, 2011. This summary was updated by ECRI Institute on April 13, 2012 following the U.S. Food and Drug Administration advisories on Statin Drugs and Statins and HIV or Hepatitis C drugs. This summary was updated by ECRI Institute on March 10, 2014 following the U.S. Food and Drug Administration advisory on Low Molecular Weight Heparins.

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